Names_____
(*Prior coordination with me is required if more than two of you work together on this project*)

Section _____

PHYSICS 315 –COMBAT AVIATION PHYSICS

Spring 2002

Application Exercise 6

Operation DEATH TO COUNTRY MUSIC

Due: *Beginning of class*, lesson 40

100 points

This application exercise is graded. To receive full credit you must show all work and communicate efficiently using proper grammar.

AUTHORIZED RESOURCES: *any published or unpublished sources and any individuals*.

Document appropriately!

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Objective: Build a jammer that really works.

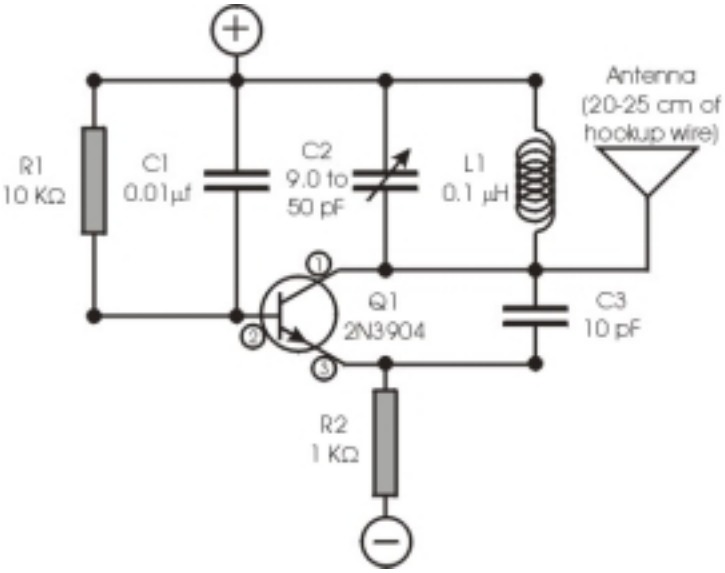
Overview: The accompanying figure shows the schematic for a simple RF oscillator. We can use this oscillator to jam the signals from FM radio stations as an example of spot jamming electronic warfare. You'll be given all the materials necessary to build your own jammer. Building this jammer will help you win your eternal fight against your roommate's sick taste in radio stations.

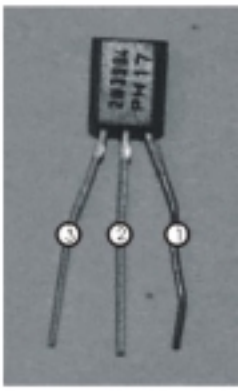
Equipment

Radio (Shared)	1 kΩ Resistor
Small Screwdriver (Shared)	10 kΩ Resistor
Capacitance Meter (Shared)	10 pF Capacitor
Wire Jumper Kit (Shared)	.01 μF Capacitor
Multimeter (Shared)	9-50 pF Trim (Adjustable) Capacitor
9 Volt Battery Jumper	0.1 μH Inductor
9 Volt Battery	2N3904 Transistor
JE24 Breadboard	Piece of Wire ("Antenna")

The trim capacitor is distinguished by the screw head on its top. The resistors have different colored bands on their body (you can distinguish the two with a multimeter). The inductor is wrapped in gray plastic. The 10 pF capacitor is blue, the 0.01 μF capacitor green. Micro (μ) is the prefix standing for 10^{-6} and pico (p) is the prefix standing for 10^{-12}. For the antenna you can use either the bare piece of wire or the longest insulated wire from the jumper kit.

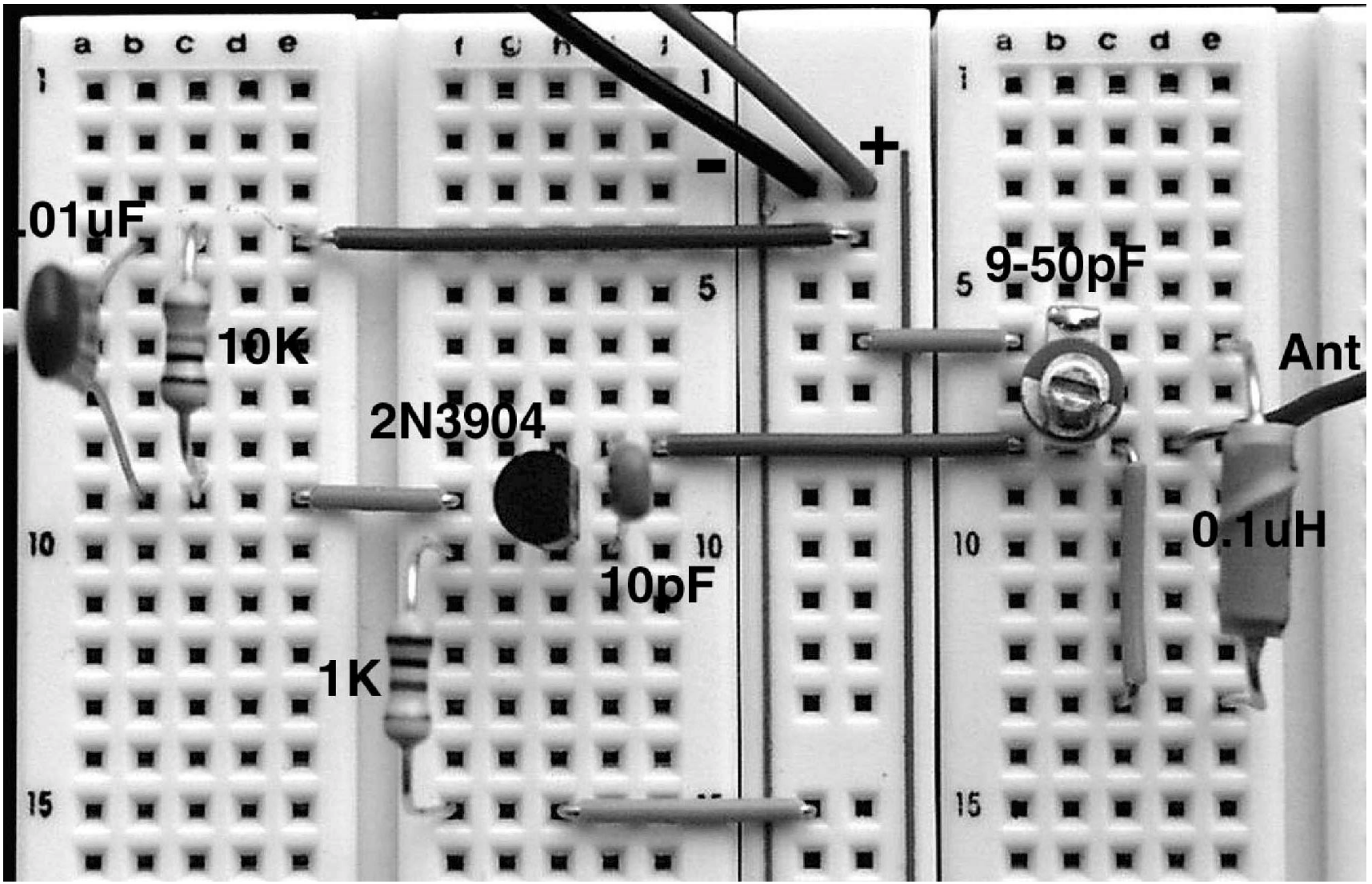
Circuit: This figure shows the circuit you are to construct.





The '+' and '– 'indicate that the circuit should be connected to the positive and negative terminals of the battery at these locations (preferably through the central power supply columns of the breadboard). The circular object with the lines and arrow inside is the transistor. The lines leading to the outside of the circle indicate the three prongs. These are labeled 1, 2 and 3. These same prongs are labeled in the photograph. The transistor produces the oscillating power source that will be tuned by the resonating C2—L1 capacitor-inductor combination.

On the adjoining page I've included a photograph of a pre-constructed circuit. If you are terribly intimidated by the circuit diagram, do your best to imitate the photograph.


a b c d e
f g h i j
1
5
10
15
+
-
.01uF
10K
2N3904
10pF
1K
9-50pF
Ant
0.1uH

1. **(30 points)** Properly build and test this jammer. Instructor confirmation required for points.

2. **(40 points)** In an LC circuit, electric charge flow back and forth between an inductor and a capacitor. These moving charges create an oscillating electric field that generates an EM wave at a well-defined frequency. This frequency is given by the equation $f = \frac{1}{2\pi\sqrt{LC}}$.

   a. What is an inductor and how does it store energy? What is a capacitor and how does it store energy?

   b. In this circuit, the *variable* capacitor C2 and the inductor L1 generate the RF oscillations. What is the range of possible EM frequencies, given the numerical range of capacitor C2?

   c. If you want to jam the dreadful country music radio station at 102 MHz (CS102 FM), to what capacitance should you tune the variable capacitor?

3. **(30 points)** When you jam the FM radio station, we don't hear any noise from the speakers; the radio just becomes quiet. We certainly are producing electromagnetic waves, so why don't we instead hear a loud static noise covering up the music? To receive full credit, you must include a phasor diagram in your answer. *Hint: think about the phasor diagrams for how an FM signal works, and think about how our jammer alters those phasors.*